Total Maximum Daily Loads Development for Sandy Bottom Branch and Unnamed Tributary to Sandy Bottom Branch

Public Meeting

February 19, 2009

DEQ
Virginia Department of Environmental Quality

William & Mary
VIMS
Virginia Institute of Marine Science
School of Marine Science

Why We Are Here

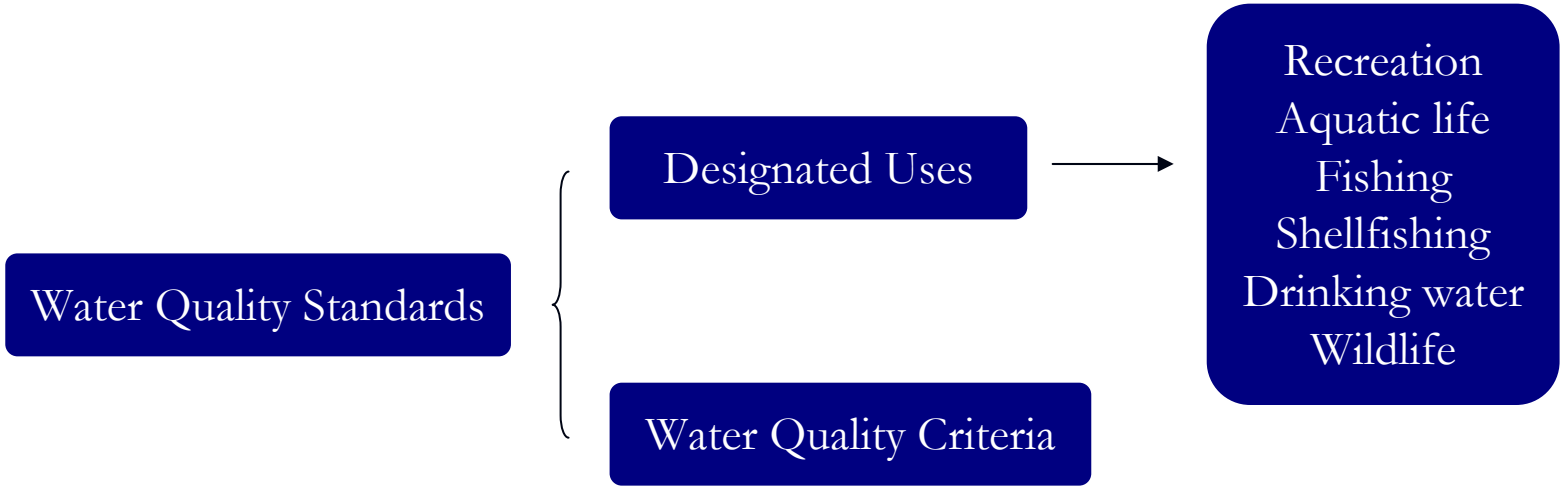
1. Learn about the water quality of Sandy Bottom Branch (SBB) and Unnamed Tributary to Sandy Bottom Branch (UTSBB)
2. Discuss the Total Maximum Daily Load (TMDL) development
3. Gather comments and encourage public participation

The TMDL Process

- **DEQ routinely monitors the quality of waters across the state and publishes a list of impaired waters every 2 years (303(d) list)**

- **Virginia is required by law to establish a TMDL for each pollutant causing an impairment**

- **A TMDL is the amount of a particular pollutant that a stream can receive and still meet Water Quality Standards (WQS)**



TMDL=WLA+LA+MOS

Where

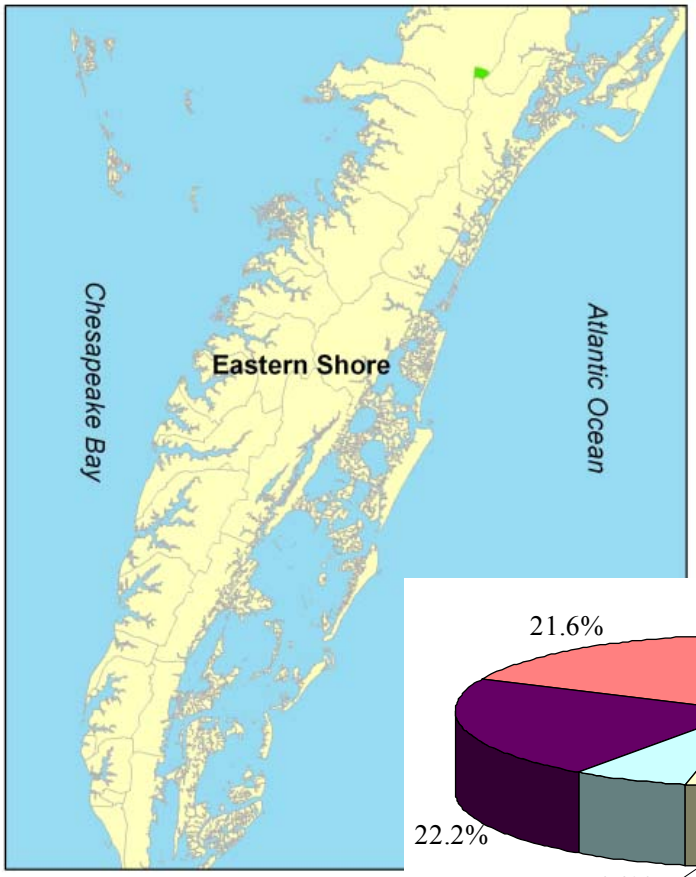
TMDL=Total Maximum Daily Load

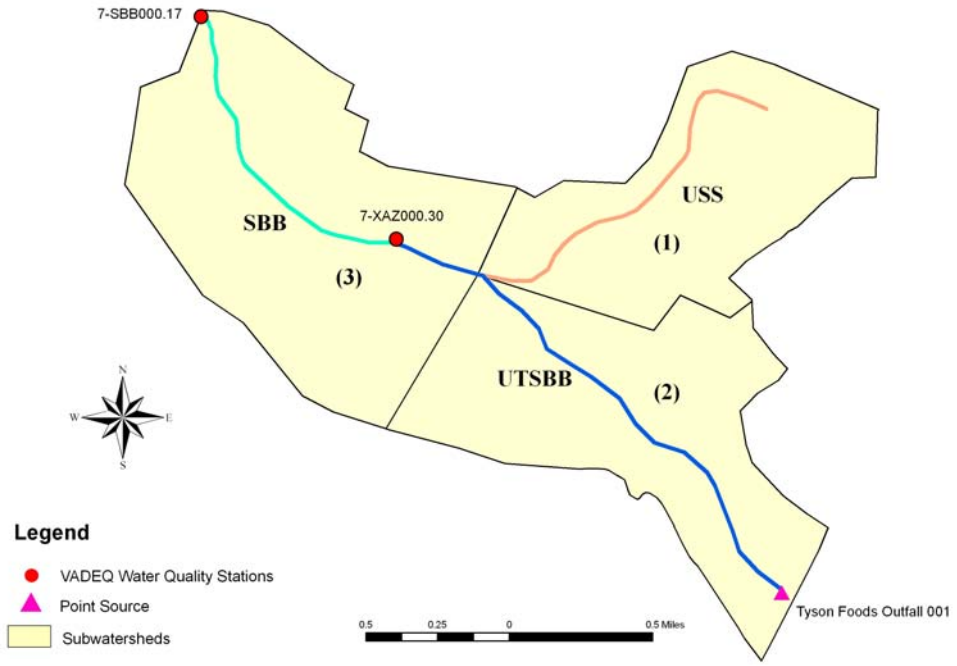
WLA=Waste Load Allocation (Point Sources)

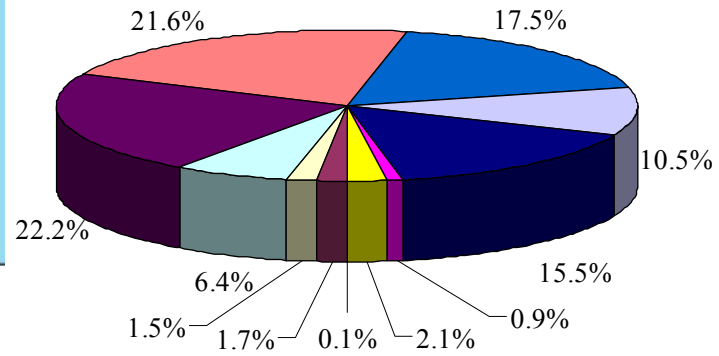
LA=Load Allocation (Nonpoint Sources)

MOS=Margin of Safety

SBB and UTSBB were first listed on 303(d) Water Quality Integrated Report in 2004 and 1998 due to WQS violation for aquatic life use.







Landuse: Dominated by forest (50.9%) & agriculture (39.4%)

Stressor Identification

- **To identify what pollutant(s) is(are) causing the benthic community impairment**
- **Common stressors:**
  - Dissolved Oxygen
  - Nutrients
  - pH
  - Temperature
  - Sediment
  - Toxics

Stressor Identification

- **Data used in Stressor Identification process:**
  - Biological monitoring data
  - Habitat assessment data
  - In-stream water quality data
- **Each candidate stressor was evaluated based on available data and consideration of potential sources in the watershed**
- **Potential stressors were further classified as a *non-stressor, possible stressor, or most probable stressor***

- **VADEQ Biological Monitoring Data (1994-2007)**

•Coastal Plain Macroinvertebrate Index (CPMI): collecting, aggregating, and interpreting benthic macroinvertebrate data for low-gradient streams of the coastal plain.

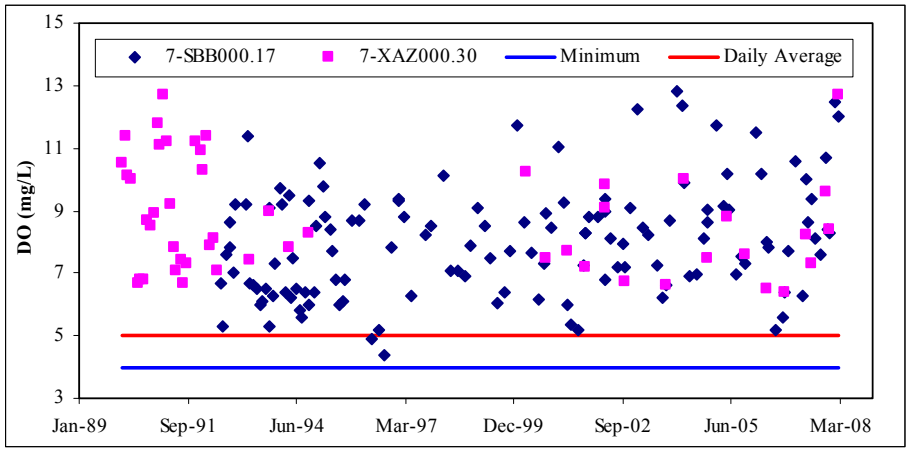
•4 out of 29 assessments at Station 7-XAZ000.30 and none at Station 7-SBB000.17 were listed as "severely impaired". All the other results were "moderately" or "slightly impaired".

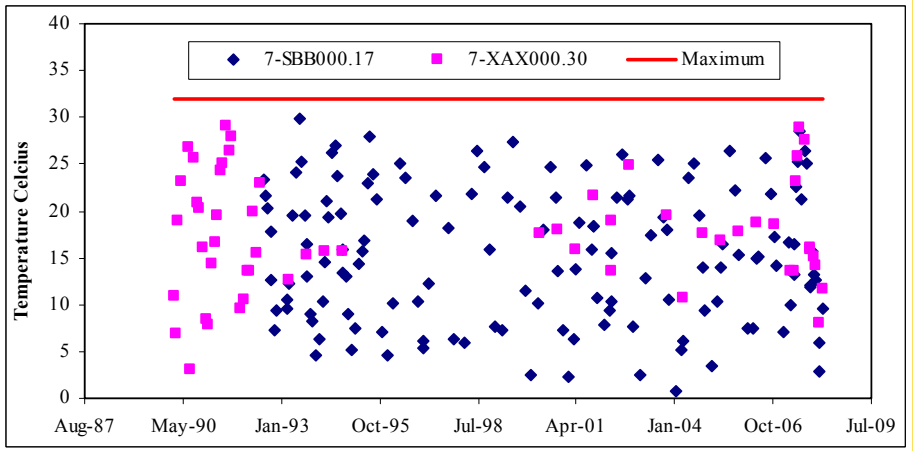
Habitat Assessment Scores

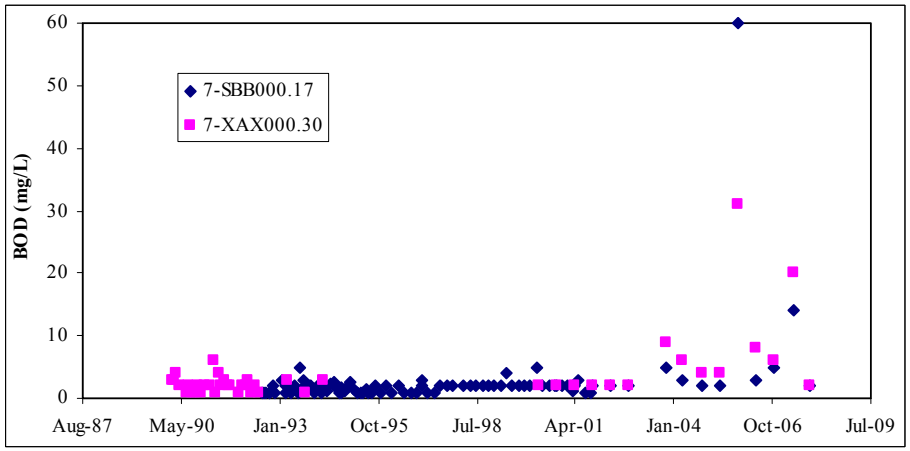
- **0-very poor; 20-optimal. The scores were compared with a reference site.**
- **Total score of the impacted site > reference site, indicating the habitat quality does not play a significant role in the benthic impairment.**

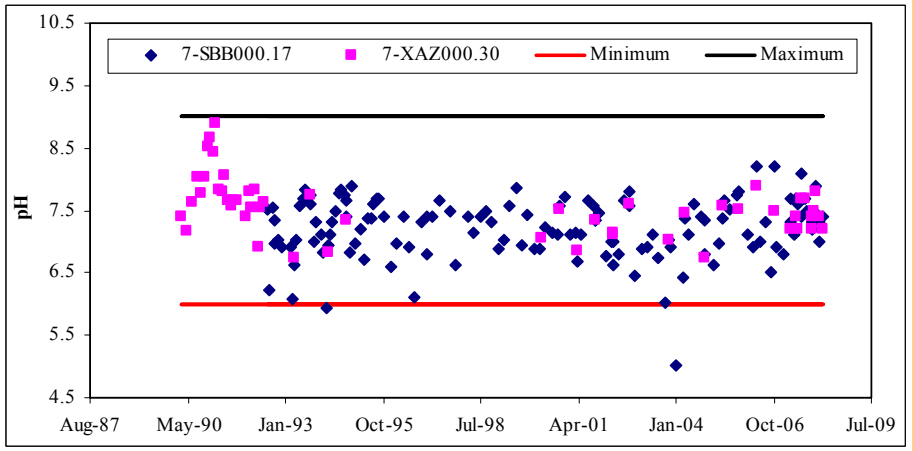
	Definition	Impacted	Reference
Channel Modification	Channelization or dredging conditions	10	15
In-stream Habitat	Scored based on the value of in-stream habitat to the fish community	14	16
Pools	Variety and complexity of slow or still Water habitat present at a site	15	15
Bank Stability	Scored based on the stability of the bank	12	10
Bank Vegetative Type	Types of vegetations on banks	16	13
Shading	Ratio of stream that is shaded	15	16
Riparian Zone Width	Minimum width of vegetated riparian Buffer	18	5
Total		**100**	**90**

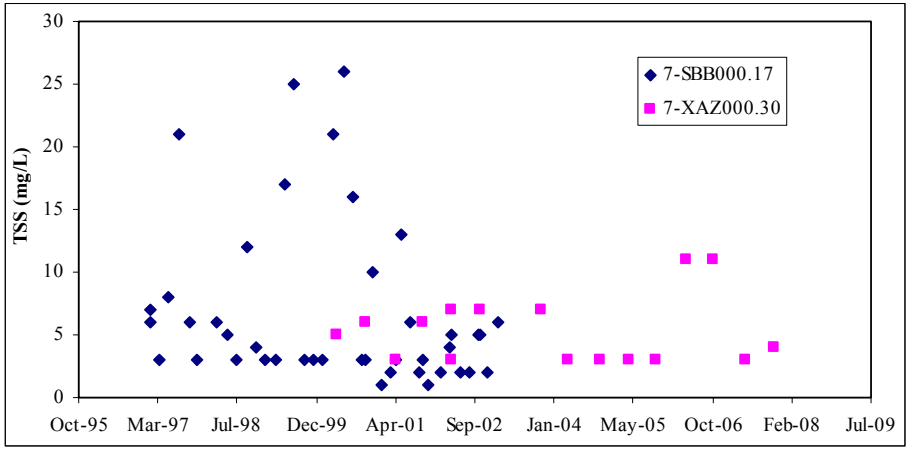
Ambient Water Quality Monitoring Data

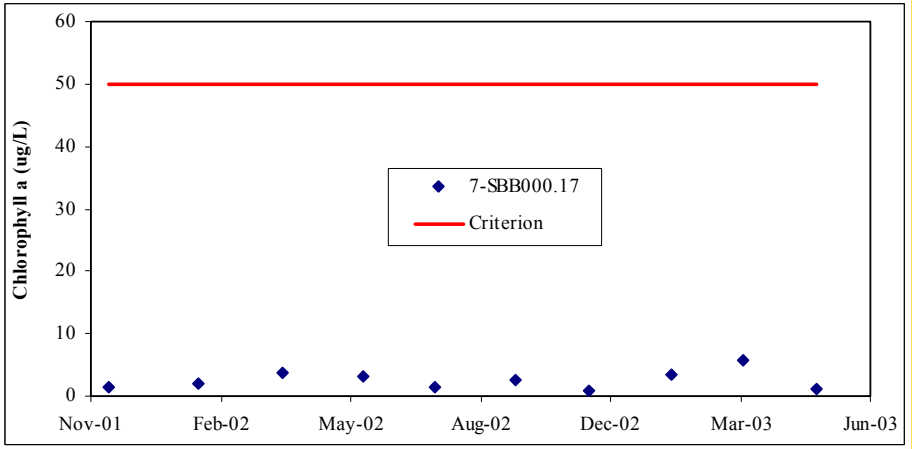


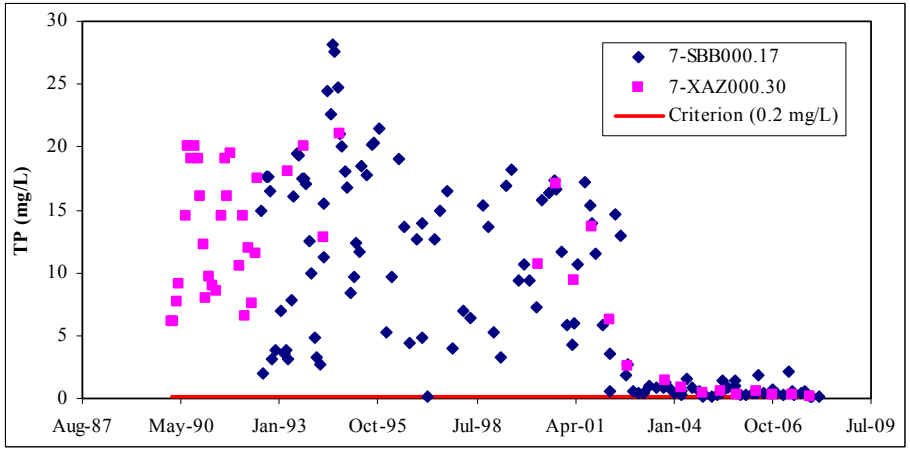


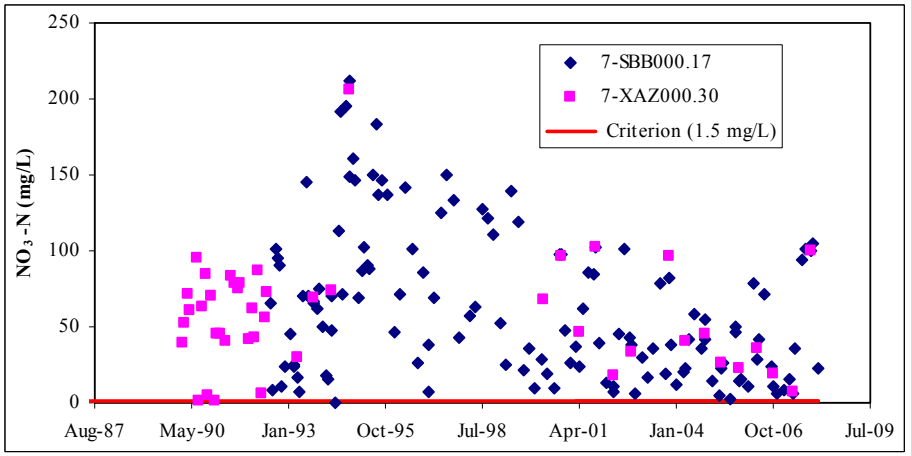


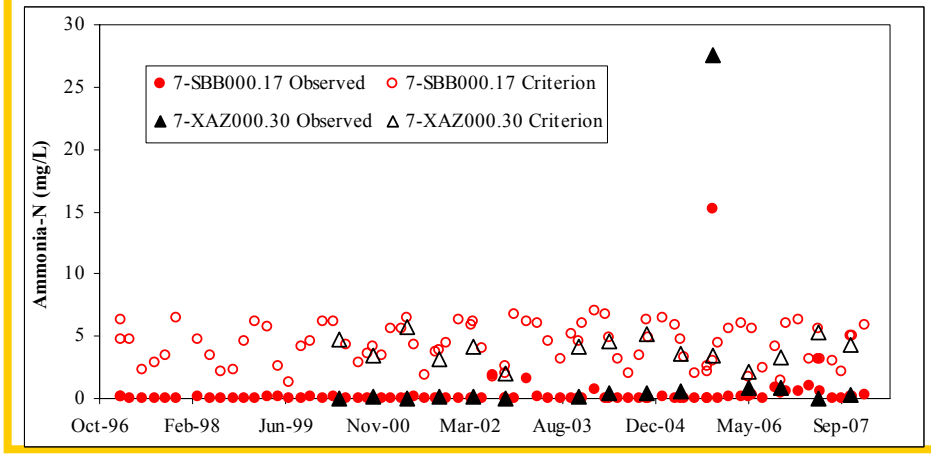


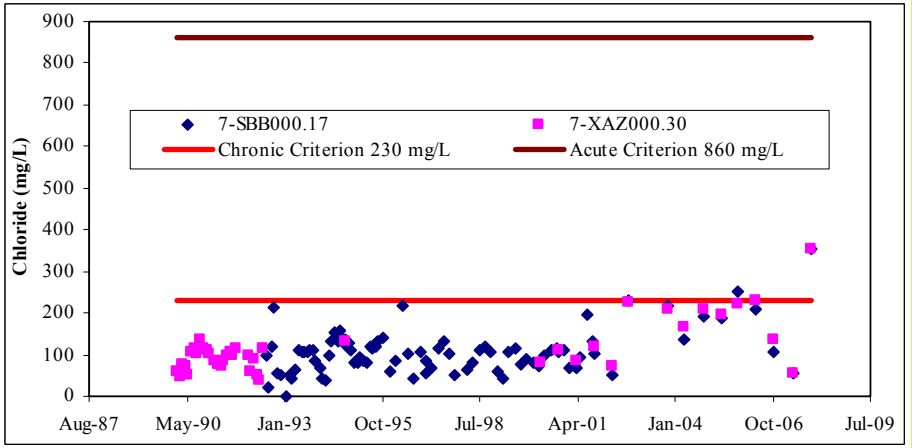

TSS (mg/L)
7-SBB000.17
7-XAZ000.30
Oct-95
Mar-97
Jul-98
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09


Chlorophyll a (ug/L)
7-SBB000.17
Criterion
Nov-01
Feb-02
May-02
Aug-02
Dec-02
Mar-03
Jun-03


TP (mg/L)
7-SBB000.17
7-XAZ000.30
Criterion (0.2 mg/L)
Aug-87
May-90
Jan-93
Oct-95
Jul-98
Apr-01
Jan-04
Oct-06
Jul-09


NO3-N (mg/L)
7-SBB000.17
7-XAZ000.30
Criterion (1.5 mg/L)
Aug-87
May-90
Jan-93
Oct-95
Jul-98
Apr-01
Jan-04
Oct-06
Jul-09


Ammonia-N (mg/L)
7-SBB000.17 Observed
7-SBB000.17 Criterion
7-XAZ000.30 Observed
7-XAZ000.30 Criterion
Oct-96
Feb-98
Jun-99
Nov-00
Mar-02
Aug-03
Dec-04
May-06
Sep-07

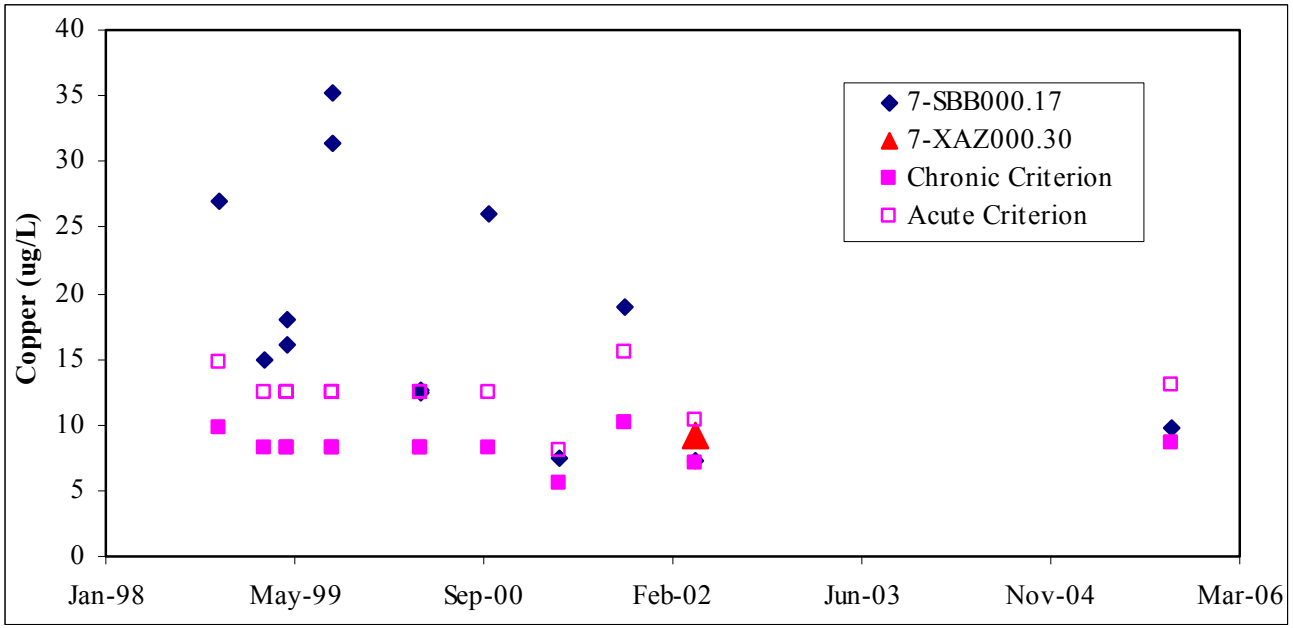

Chloride (mg/L)
7-SBB000.17
7-XAZ000.30
Chronic Criterion 230 mg/L
Acute Criterion 860 mg/L
Aug-87
May-90
Jan-93
Oct-95
Jul-98
Apr-01
Jan-04
Oct-06
Jul-09

Organic Contaminants

- No data collected in the water column.
- Sediment organics data were available at Station 7-SBB000.17: aldrin, chlordane, DDT, DDD, DDE, dicofol, dieldrin, endrin, heptachlor epoxide, heptachlor, PCBs, and toxaphene.
- All of them were below the detection limits or the standards.

Heavy Metals

- Measured heavy metals: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), thallium (Ti), and zinc (Zn)
- In sediment, heavy metals were below the standards or the detection limits, or did not have standard, except one measurement at Station 7-XAZ000.30 in 1990 had spiked Cr concentration.
- In water column, all heavy metals complied with WQC or did not have an established WQC, except Cu.



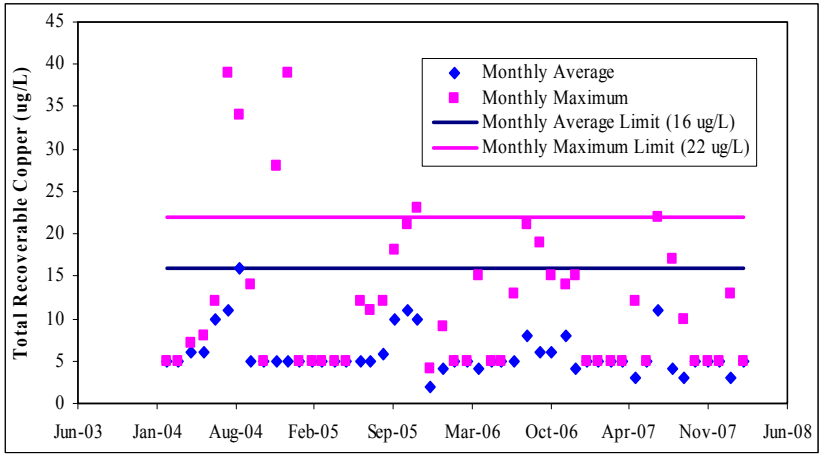
Stressor Identification Summary

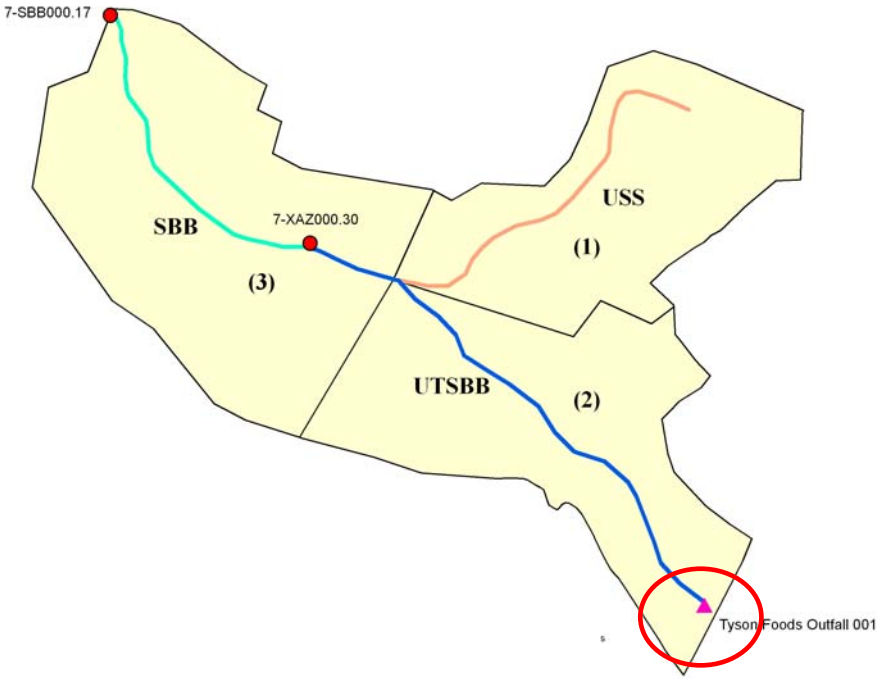
Category	Candidate
Non-Stressors	Low DO, pH, Temperature, Dissolved Heavy Metals in Water Column except Cu, Heavy Metals in Sediment, Organic Contaminants in Sediment
Possible Stressors	Nutrients, Chloride
Most Probable Stressors	**Dissolved Cu in Water Column**

Dissolved Cu TMDL Development

Source Assessment

•Point Source -- Tyson Farms Incorporated





$$Cu_{Dissolved} = Cu_{Total\ Recoverable} \times 0.76$$

•Nonpoint Source -- Background Cu washed off from soils in the watershed

TMDL Endpoint: Hardness-Dependent

- Freshwater acute criterion (mg/l)

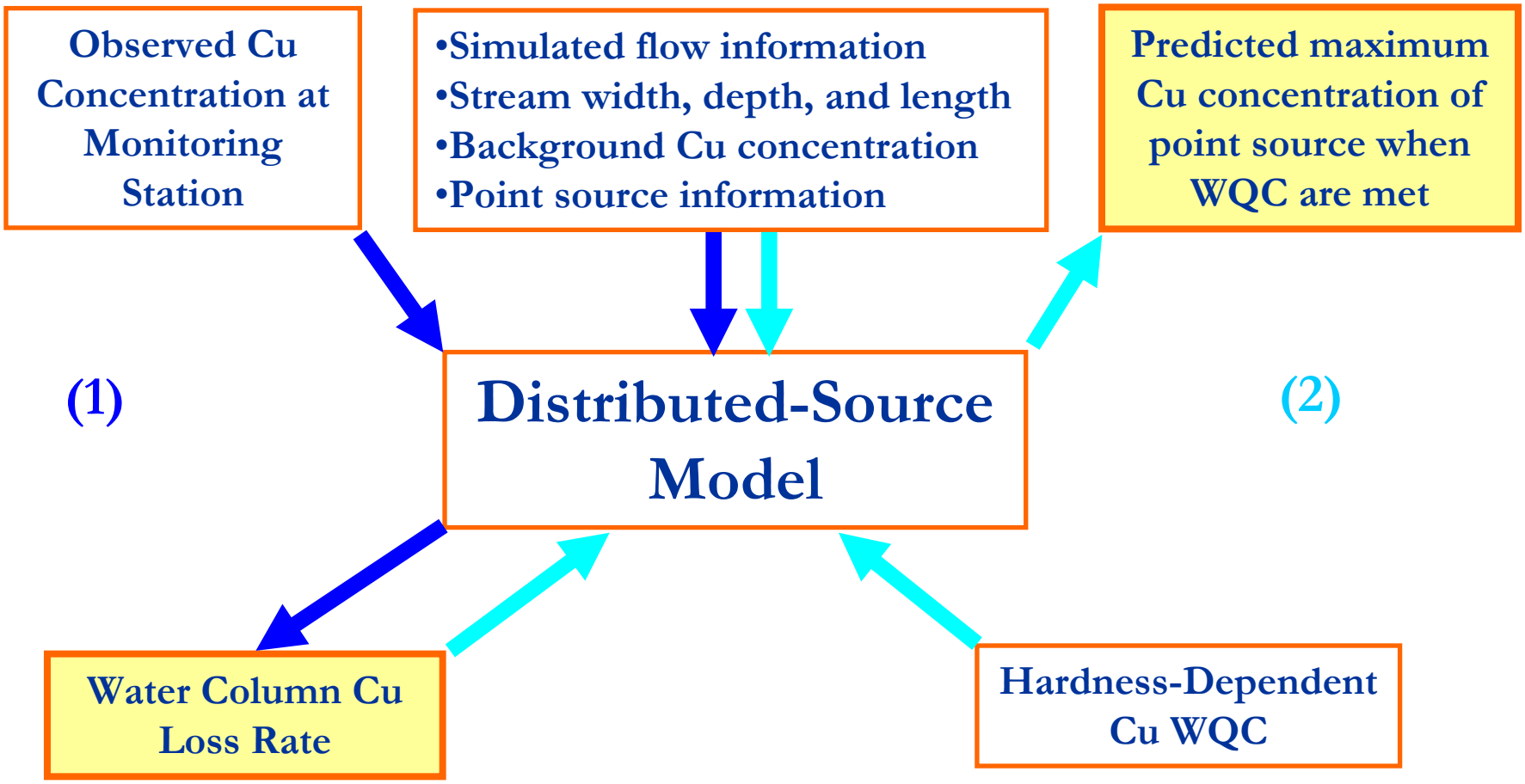
  WER [e{0.9422[ln(hardness)]-1.700}] (CFa)

- Freshwater chronic criterion (mg/l)

  WER [e{0.8545[ln(hardness)]-1.702}] (CFc)

WER = Water Effect Ratio =1 unless shown otherwise under 9 VAC 25-260-140.F and listed in 9 VAC 25-260-310.
CFa = 0.960; CFc = 0.960

Modeling Approach: Linking Sources to Water Quality



Step (1): Calculate the Cu loss rate

Step (2): Predict the maximum Cu levels of the point source in order to meet the WQC

Distributed-Source Model:

Assumptions:

1. **Non-point source loads are discharged laterally into the system**
2. **Cu is fully mixed laterally and vertically**

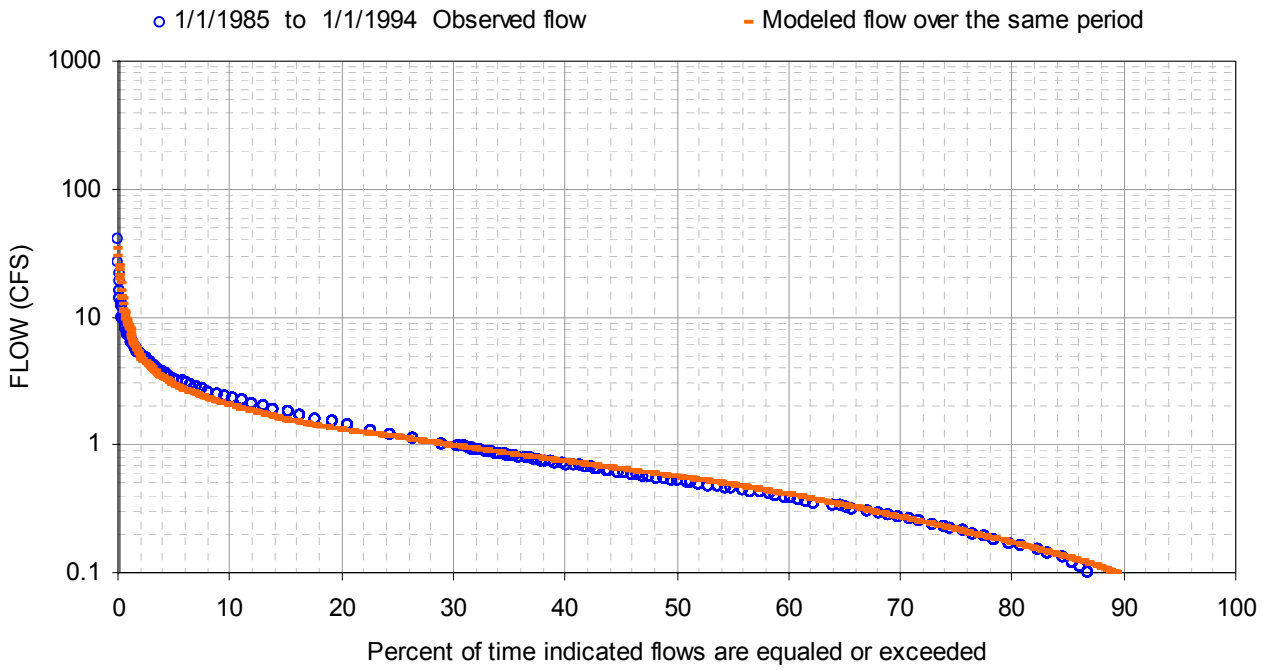
$$C = \frac{S_0}{k}\left(1 - e^{-\frac{k}{u}x}\right) + C_0 e^{-\frac{k}{u}x}$$

Non-Point Source **Point Source**

S_0: nonpoint source load
k: Cu first-order loss rate
u: water velocity, $u = Q/A$ (in-stream flow/cross-sectional area)
x: distance measured from headwater
C_0: Cu concentration of the point source discharge

Flow Estimation:

To estimate the velocity, u, an in-stream flow Q is required. The LSPC model was calibrated against USGS Gage 01484800 in Guy Creek near Nassawadox and used to simulate the daily flow.

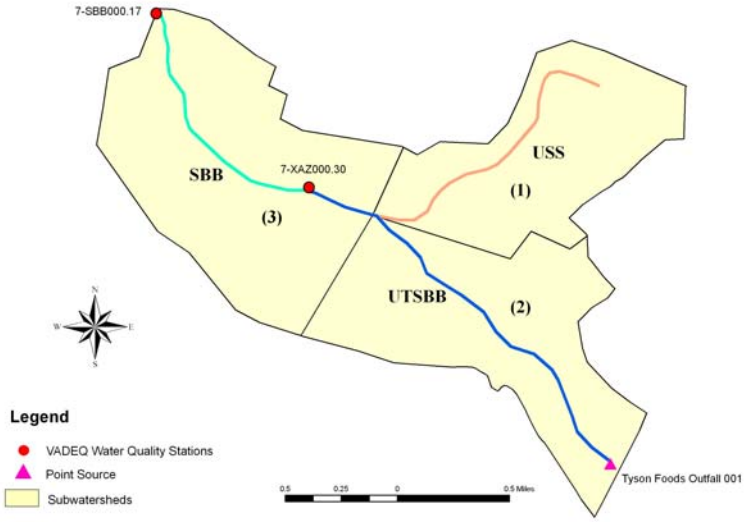


The average in-stream dissolved Cu concentration in Eastern Shore was used as the background concentration (0.682±0.295 ug/L) for SBB. The measured Cu at Station 7-SBB000.17 was subtracted by this value, thus S_0 becomes 0.

$$C_1 = \frac{S_{01}}{k}(1-e^{-\frac{k}{u_1}x_1}) + C_{01}e^{-\frac{k}{u_1}x_1} = C_{01}e^{-\frac{k}{u_1}x_1} = 0$$

$$C_2 = \frac{S_{02}}{k}(1-e^{-\frac{k}{u_2}x_2}) + C_{02}e^{-\frac{k}{u_2}x_2} = C_{02}e^{-\frac{k}{u_2}x_2}$$

$$C_3 = \frac{S_{03}}{k}(1-e^{-\frac{k}{u_3}x_3}) + C_{03}e^{-\frac{k}{u_3}x_3} = C_{03}e^{-\frac{k}{u_3}x_3}$$



$$C_3 = \frac{q_2 + q_{Tyson}}{q_1 + q_2 + q_{Tyson}} \times C_{02} \times e^{-k(\frac{x_2}{u_2}+\frac{x_3}{u_3})}$$

k=0.18/day

q1, *q2*, and q_{Tyson} are the background flows from sub-watersheds 1 and 2, and Tyson Farms

Consequently, the hardness-dependent Cu WQC at the two DEQ stations were substituted into the same equation (as C_3) , and C_{02}, the maximum Cu concentrations of Tyson Farms required to meet the WQC, were calculated for different flow categories: low, median, and high flows.

$$C_3 = \frac{q_2 + q_{Tyson}}{q_1 + q_2 + q_{Tyson}} \times C_{02} \times e^{-k(\frac{x_2}{u_2} + \frac{x_3}{u_3})}$$

Maximum Total Recoverable Cu Concentrations of Tyson (ug/L) to Meet the WQC at Station 7-SBB000.17

Hardness (mg/L)	Acute Criteria	C Tyson High Flow	C Tyson Median Flow	C Tyson Low Flow
48	6.73	17	14	12
58	8.04	20	17	15
68	9.34	24	20	17
78	10.63	27	23	20
88	11.91	31	26	22
98	13.19	34	29	25
108	14.45	38	32	27
118	15.71	41	35	30
128	16.96	44	38	32

Hardness (mg/L)	Chronic Criteria	C Tyson High Flow	C Tyson Median Flow	C Tyson Low Flow
48	4.78	11	9	8
58	5.62	14	11	10
68	6.44	16	13	11
78	7.24	18	15	13
88	8.03	20	17	15
98	8.80	22	19	16
108	9.56	24	20	18
118	10.32	26	22	19
128	11.06	28	24	20

Maximum Total Recoverable Cu Concentrations of Tyson (ug/L) to Meet the WQC at Station 7-XAZ000.30

Hardness (mg/L)	Acute Criteria	C Tyson High Flow	C Tyson Median Flow	C Tyson Low Flow
48	6.73	11	9	8
58	8.04	14	12	10
68	9.34	17	14	12
78	10.63	20	17	14
88	11.91	23	19	17
98	13.19	26	22	19
108	14.45	29	24	21
118	15.71	32	27	23
128	16.96	34	29	25

Hardness (mg/L)	Chronic Criteria	C Tyson High Flow	C Tyson Median Flow	C Tyson Low Flow
48	4.78	10	8	7
58	5.62	12	10	8
68	6.44	14	11	10
78	7.24	15	13	11
88	8.03	17	15	13
98	8.80	19	16	14
108	9.56	21	18	15
118	10.32	23	19	16
128	11.06	24	21	18

Tyson Farms Total Recoverable Cu Data

- **Permit Limit:**
  Mean – 16 ug/L
  Maximum – 22 ug/L

  Observed:
  Average of the Mean – 6 ug/L
  Average of the Maximum – 12 ug/L
  90% percentile of the Mean – 10 ug/L
  90% percentile of the Maximum – 22 ug/L

Continued Work

- Collect comments and suggestions
- Calculate the current load, TMDL, and load reductions
- Finalize TMDL reports

Questions?